Tax Evasion, Technology Shocks, and the Cyclicality of Government Revenues *

Judith Panadés

Unitat de Fonaments de l'Anàlisi Econòmica

Universitat Autònoma de Barcelona

September 19, 2007

Abstract

This paper analyzes the behavior of the tax revenue to output ratio over the business cycle. In order to replicate empirical evidence I develop a simple model combining the standard Ak growth model with the tax evasion phenomenon. When individuals conceal part of their true income from the tax authority, they face the risk of being audited and hence of paying the corresponding fine. In this setup, the effect of a positive technological shock on the government revenue to output ratio is fully characterized by the value of intertemporal elasticity of substitution (IES). In particular, under the empirically plausible assumption that the IES exhibits a sufficiently small value, I show that the elasticity of government revenue with respect to output is larger than one, which agrees with the empirical evidence.

JEL Classification Number: H23, H26, O41

Key words: Tax evasion, technological shocks, growth

* Financial support from Fundación BBVA is gratefully acknowledged

Correspondence address: Judith Panadés. Universitat Autònoma de Barcelona. Departament d'Economia i d'Història Econòmica. Edifici B. 08193 Bellaterra (Barcelona). Spain.

Phone: (34)-935.811.802. *Fax:* (34)-935.812.012. *E-mail:* Judith.Panades@uab.es

1. Introduction

In their seminal paper, Kyland and Prescott (1982) introduced some novel ideas, which constituted the starting point for a new approach to the study of business cycle behavior. One of these ideas is that it is possible to unify business cycle and growth theory by emphasizing that business cycle models must be consistent with the empirical stylized facts of long-run growth. Most authors who have followed the approach proposed by Kyland and Prescott have based their work on the role played by real technology shocks in driving business fluctuations.

The behavior of government revenue over the business cycle has received some attention in the empirical literature of recent years. It is well known that economic recessions tend to reduce the tax revenue making it difficult for governments to fund their existing programs. Moreover, during expansion periods tax revenue increases creating additional pressure on the government to increase public spending. Therefore, empirical research of this question focuses on performing estimates of the income elasticity of tax revenue in order to find out whether tax revenues have a more than proportional response to output fluctuations.[1] It is important to distinguish between the long-run income elasticity of tax revenue which indicates how revenues will grow over time as income grows, and the short-run income elasticity of tax revenue which indicates how much revenues will fluctuate over the business cycle. For instance, Holcombe and Sobel (1997) estimate both the short-run personal income elasticity of tax revenue and the short-run personal income elasticity of the tax base for U.S. states and find that on average they are equal to 1.392 and 1.192 respectively.[2] Hence, the average elasticity estimate suggests that a one percent increase in personal income should result in a 1.4 percent increase in the tax revenue. Recent studies by Dye and Merriman (2004) and Bruce et al. (2006) provide more accurate estimates which

[1] See Dye (2004) for a review of this literature.

[2] Researchers distinguish between two tax measures to use in estimating elasticities: the tax base or the tax revenue. Tax revenue data by the type of tax is easily available for several developed countries, but it can include changes of the tax rate which leads to bias in the short-run elasticity estimator.

support the idea that the short-run personal income elasticity of the tax base tends to be larger than one.

The main objective of this paper is to provide a theoretical setup that can be consistent with the empirical findings. The standard Ak growth model with flat tax rates predicts that the government revenue to output ratio remains constant when a technology shock takes place. Under flat tax rates, a technology shock affects both output and government revenue in the same way since government revenue is a constant proportion of the output. Therefore, the standard Ak growth model with flat tax rates does not offer a plausible explanation for the empirical evidence since the short-run income elasticity of tax revenue that the model predicts is equal to one. In order to agree with empirical facts better I endow the standard Ak growth model with tax evasion. I consider a capital accumulation model where individuals have to choose in each period the amount of income they want to consume and the amount of income they want to evade. When individuals conceal part of their true income from the tax authority, they face the risk of being audited and hence of paying the corresponding fine. Both taxes and fines determine individual saving and the rate of capital accumulation. Two types of shocks coexist in this model the aggregate shock, which is given by changes in the total factor productivity of the economy and the idiosyncratic shock, which is introduced by means of the tax evasion inspection policy. The main result shows that when technology shocks are correlated, the value of intertemporal elasticity of substitution (IES, henceforth) fully determines the behavior of the government revenue to output ratio. In particular, when the inverse of IES is larger than one, the government revenue increases more than the output in the presence of a positive technology shock. In this case, the elasticity of tax revenue with respect to output is larger than one, which is consistent with the empirical regularity. Moreover, when the IES is equal to one or technology shocks are not correlated, the result of the standard Ak model is recovered.

In the next section I develop the basic model with penalties proportional to the amount of evaded taxes. In Section 3 I will discuss the implications of a technology shock on the government revenue to output ratio. Some final remarks conclude the article.

2. The Model

Let us consider a competitive economy in discrete time with a continuum of identical individuals who are uniformly distributed on the interval $[0,1]$. Each individual i has access to a common technology represented by the production function $y_{i,t} = \tilde{A}_t k_{i,t}$ where $\tilde{A}_t > 0$ is the random total factor productivity, $y_{i,t}$ is the output per capita of individual i and $k_{i,t}$ is the capital per capita of individual i in period t.[3] Therefore, production is exposed to technology shocks which make $\tilde{A}_t$ random.

I assume that the stochastic process of technology shocks $\left\{\tilde{A}_t\right\}$ follows a logarithmic autoregressive process

$$\ln \tilde{A}_{t+1} = \rho \ln \tilde{A}_t + \tilde{\varepsilon}_{t+1}, \tag{2.1}$$

where $\rho \in [0,1]$ and $\tilde{\varepsilon}_{t+1}$ is normally distributed with mean zero and variance σ^2. Under this specification, the behavior of the process $\left\{\tilde{A}_t\right\}$ is determined by the serial correlation parameter ρ and the standard deviation σ of the noise $\tilde{\varepsilon}_{t+1}$.

Output can be devoted to either consumption or investment. After production has taken place, each individual i decides both his consumption $c_{i,t}$ and the amount $x_{i,t}$ of declared income, and then pays the corresponding income tax at the rate $\tau \in (0,1)$. If he is inspected by the tax enforcement agency, the total amount of unreported income is discovered and the taxpayer has to pay a penalty at the flat rate $\pi > 1$, which is imposed on the amount of evaded taxes (as in Yitzhaki, 1974).[4] Inspection of a particular individual is an event that occurs with probability $p \in (0,1)$. We also assume that $p\pi < 1$ in order to ensure positive tax evasion.

The amount of output remaining after consumption has taken place and taxes and (potential) penalties have been paid constitutes the capital stock $k_{i,t+1}$ that is used for the next production period. Therefore, the budget constraint of an audited individual is

$$\tilde{A}_t k_{i,t} - \tau x_{i,t} - \pi\tau\left(\tilde{A}_t k_{i,t} - x_{i,t}\right) = c_{i,t} + k_{i,t+1},$$

[3] See Rebelo (1991) for a model where the Ak production function rises endogenously when physical and human capital are perfect substitutes. In this case the capital stock k embodies both kinds of capital.

[4] If the penalty rate π were smaller than one, evading taxpayers would never be punished.

whereas the budget constraint of a non-audited individual is

$$\tilde{A}_t k_{i,t} - \tau x_{i,t} = c_{i,t} + k_{i,t+1}.$$

We assume that the amount of taxes collected by the tax agency is devoted to financing government spending that enters into the instantaneous utility of individuals in an additive way. Therefore, the marginal rate of substitution of private consumption between two arbitrary periods is not affected by the level of government spending. Since consumers take as given the path of government spending, the utility accruing from this spending can be suppressed from the consumers' objective function. Individuals are assumed to maximize the following discounted sum of instantaneous utilities:

$$\sum_{t=0}^{\infty} \beta^t u\left(c_{i,t}\right), \tag{2.2}$$

where $\beta \in (0,1)$ is the discount factor. I assume that the utility function is isoelastic,

$$u\left(c_{i,t}\right) = \frac{1}{1-\gamma} c_{i,t}^{1-\gamma},$$

where γ plays a double role: (i) it is the value of the (constant) relative risk aversion index, and (ii) it is the inverse of IES.

The amount of unreported income in period t for each individual i, is $e_{i,t} = \tilde{A}_t k_{i,t} - x_{i,t}$. Hence, I can use the previous budget constraints to write the law of motion of capital per capita as

$$k_{i,t+1} = \begin{cases} \left(1-\tau\right)\tilde{A}_t k_{i,t} - c_{i,t} + \tau(1-\pi)e_{i,t}, & \text{with probability } p, \\ \\ \left(1-\tau\right)\tilde{A}_t k_{i,t} - c_{i,t} + \tau e_{i,t}, & \text{with probability } (1-p), \end{cases}$$

or, equivalently,

$$k_{i,t+1} = \left(1-\tau\right)\tilde{A}_t k_{i,t} - c_{i,t} + \tau e_{i,t}\tilde{h}_i, \tag{2.3}$$

where $\widetilde{h}$ is a random variable with the following probability function:

$$f\left(h\right) = \begin{cases} p & \text{for} \quad h = 1-\pi, \\ \\ 1-p & \text{for} \quad h = 1. \end{cases} \tag{2.4}$$

Note that $E\left(\widetilde{h}\right) = 1 - p\pi > 0$ because of the assumption $p\pi < 1$, which guarantees that some evasion takes place. I define the net true income per capita as

$$n_{i,t} = (1-\tau)\,\tilde{A}_t k_{i,t}. \tag{2.5}$$

Then, using (2.3) I can compute $n_{i,t+1}$ as

$$n_{i,t+1} = (1-\tau)\,\tilde{A}_{t+1}\left(n_{i,t} - c_{i,t} + \tau e_{i,t}\tilde{h}_i\right) \tag{2.6}$$

The Bellman equation for the stochastic dynamic problem faced by an individual is

$$V\left(k_{i,t}\right) = \underset{c_{i,t},\, e_{i,t}}{Max}\left\{\frac{1}{1-\gamma}\left(c_{i,t}\right)^{1-\gamma} + \beta E_t\left[V\left(n_{i,t+1}\right)\right]\right\}, \tag{2.7}$$

where $n_{i,t+1}$ satisfies (2.6) . It is well known that the value function for this problem is an affine transformation of the isoelastic function, $V\left(n_{i,t}\right) = \frac{D}{1-\gamma}\left(n_{i,t}\right)^{1-\gamma}$with $D > 0$ (see Hakansson, 1970). Therefore, using (2.6) and computing the conditional expectation $E_t\left[V\left(n_{i,t+1}\right)\right]$, the optimization problem faced by a taxpayer with initial net true income $n_{i,t}$ becomes

$$\underset{c_{i,t},\, e_{i,t}}{Max}\left\{\frac{1}{1-\gamma}\left(c_{i,t}\right)^{1-\gamma} + \beta E_t\left[\frac{D}{1-\gamma}\left((1-\tau)\,\tilde{A}_{t+1}\left(n_{i,t} - c_{i,t} + \tau e_{i,t}\tilde{h}_i\right)\right)^{1-\gamma}\right]\right\}, \tag{2.8}$$

Differentiating with respect to $c_{i,t}$ and $e_{i,t}$, I obtain the following first order conditions for the previous problem:

$$\left(c_{i,t}\right)^{-\gamma} = \beta D E_t\left[\left((1-\tau)\,\tilde{A}_{t+1}\right)^{1-\gamma}\left(n_{i,t} - c_{i,t} + \tau e_{i,t}\tilde{h}_i\right)^{-\gamma}\right], \tag{2.9}$$

and

$$(1-p)\left(n_{i,t} - c_{i,t} + \tau e_{i,t}\right)^{-\gamma} = p\,(\pi - 1)\left(n_{i,t} - c_{i,t} + \tau\,(1-\pi)\,e_{i,t}\right)^{-\gamma}. \tag{2.10}$$

Since I assume that $\tilde{A}_{t+1}$ and $\tilde{h}_i$ are independent, equation (2.9) can be rewritten as

$$\left(c_{i,t}\right)^{-\gamma} = \beta D(1-\tau)^{1-\gamma}\alpha E_t\left[\left(n_{i,t} - c_{i,t} + \tau e_{i,t}\tilde{h}_i\right)^{-\gamma}\right], \tag{2.11}$$

where

$$\alpha = E_t\left[\left(\tilde{A}_{t+1}\right)^{1-\gamma}\right].$$

Solving for $c_{i,t}$ and $e_{i,t}$ the system composed by equations (2.11) and (2.10), I obtain

$$c_{i,t} = \theta n_{i,t}, \tag{2.12}$$

and

$$e_{i,t} = \lambda(n_{i,t} - c_{i,t}), \tag{2.13}$$

where

$$\theta = \frac{1}{1 + \left(\beta D(1-\tau)^{1-\gamma}\alpha\left[(1-p)(1+\tau\lambda)^{-\gamma} + p\left(1-(\pi-1)\tau\lambda\right)^{-\gamma}\right]\right)^{\frac{1}{\gamma}}}, \tag{2.14}$$

and

$$\lambda = \frac{\left[\left(\frac{1-p}{p(\pi-1)}\right)^{\frac{1}{\gamma}} - 1\right]}{\tau\left[1 + (\pi-1)\left(\frac{1-p}{p(\pi-1)}\right)^{\frac{1}{\gamma}}\right]}. \tag{2.15}$$

Applying the envelope theorem, that is $U'(c_{i,t}) = V'\left(n_{i,t}\right)$, it must hold that

$$c_{i,t}^{-\gamma} = Dn_{i,t}^{-\gamma}. \tag{2.16}$$

Substituting (2.12) in (2.16) and using (2.14) is obtained

$$D = \frac{1}{1 + \left(\beta D(1-\tau)^{1-\gamma}\alpha\left[(1-p)\left(1+\tau\lambda\right)^{-\gamma} + p\left(1-(\pi-1)\tau\lambda\right)^{-\gamma}\right]\right)^{\frac{1}{\gamma}}}.$$

Therefore, D is equal to

$$D = \left[\frac{1}{1 - \beta^{\frac{1}{\gamma}}(1-\tau)^{\frac{1-\gamma}{\gamma}}\alpha^{\frac{1}{\gamma}}H^{\frac{1}{\gamma}}}\right]^{\gamma}, \tag{2.17}$$

where

$$H = (1-p)\left(1+\tau\lambda\right)^{-\gamma} + p\left(1-(\pi-1)\tau\lambda\right)^{-\gamma}.$$

Substituting (2.17) into (2.14) , (2.12), and (2.13) ,I get the following consumption and evasion policies:

$$c_{i,t} = \left(1 - \left(\beta(1-\tau)^{1-\gamma}\alpha H\right)^{\frac{1}{\gamma}}\right)n_{i,t}, \tag{2.18}$$

and

$$e_{i,t} = \lambda\left(\beta(1-\tau)^{1-\gamma}\alpha H\right)^{\frac{1}{\gamma}}n_{i,t}. \tag{2.19}$$

In order to obtain the value of the aggregate net true income in equilibrium, n_{t+1}, which is given by (2.6) I compute

$$\begin{aligned}
n_{t+1} &= \int_{[0,1]} n_{i,t+1}d_i = (1-\tau)\tilde{A}_{t+1}\left[\int_{[0,1]} n_{i,t}d_i - \int_{[0,1]} c_{i,t}d_i + \tau\int_{[0,1]} e_{i,t}\tilde{h}_i d_i\right] \\
&= (1-\tau)\tilde{A}_{t+1}\left[\int_{[0,1]} n_{i,t}d_i - \int_{[0,1]} c_{i,t}d_i + \tau\left(\int_{[0,1]} e_{i,t}d_i\right)\left(\int_{[0,1]}\tilde{h}_i d_i\right)\right] \\
&= (1-\tau)\tilde{A}_{t+1}\left[n_t - c_t + \tau\left(1-p\pi\right)e_t\right],
\end{aligned}$$

where the second equality follows from the independence between the variables $\tilde{h}_i$ and $e_{i,t}$ at the beginning of period t, whereas the last equality comes from the law of large numbers for a continuum of i.i.d. random variables according to which $\int_{[0,1]} \tilde{h}_i di = E\left(\tilde{h}_i\right) = 1 - p\pi$, and from the definitions of aggregate consumption, $c_t = \int_{[0,1]} c_{i,t} di$ and aggregate evasion, $e_t = \int_{[0,1]} e_{i,t} di$.

In consequence, the aggregate values of evaded income and consumption are

$$c_t = \left(1 - \left(\beta(1-\tau)^{1-\gamma}\alpha H\right)^{\frac{1}{\gamma}}\right) n_t, \tag{2.20}$$

and

$$e_t = \lambda \left(\beta(1-\tau)^{1-\gamma}\alpha H\right)^{\frac{1}{\gamma}} n_t. \tag{2.21}$$

In order to analyze the effect of a technology shock on evaded income and on consumption, I must compute the value of α. Expression (2.1) can be rewritten as

$$\tilde{A}_{t+1} = e^{\ln \tilde{A}_t^{\rho}} e^{\tilde{\varepsilon}_{t+1}} = \tilde{A}_t^{\rho} e^{\tilde{\varepsilon}_{t+1}}.$$

Therefore,

$$\left(\tilde{A}_{t+1}\right)^{1-\gamma} = \tilde{A}_t^{\rho(1-\gamma)} e^{\tilde{\varepsilon}_{t+1}(1-\gamma)}.$$

Then, α becomes

$$\alpha = E_t\left[\left(\tilde{A}_{t+1}\right)^{1-\gamma}\right] = A_t^{\rho(1-\gamma)} E_t\left[e^{\tilde{\varepsilon}_{t+1}(1-\gamma)}\right].$$

Given that $\tilde{\varepsilon}_{t+1}$ is normal, the random variable $e^{\tilde{\varepsilon}_{t+1}}$ is log-normal distributed. Since $E_t\left[\ln e^{(1-\gamma)\tilde{\varepsilon}_{t+1}}\right] = 0$ and $Var\left[\ln e^{(1-\gamma)\tilde{\varepsilon}_{t+1}}\right] = (1-\gamma)^2\sigma^2$, I get

$$E_t\left[e^{(1-\gamma)\tilde{\varepsilon}_{t+1}}\right] = e^{\frac{(1-\gamma)^2\sigma^2}{2}}.$$

Hence, α is equal to

$$\alpha = A_t^{\rho(1-\gamma)} e^{\frac{(1-\gamma)^2\sigma^2}{2}}. \tag{2.22}$$

The next section discusses the effect of a technology shock on both the amount of evaded income and the government revenue to output ratio.

3. Effects of technology shocks

In order to analyze the effect of a technology shock on government revenue to output ratio, I should first compute the effect of an increase of A_t on the ratio $\frac{e_t}{y_t}$. Since aggregate output satisfies $y_t = \tilde{A}_t k_t$, and substituting (2.5) and (2.22) into (2.21), I obtain

$$\frac{e_t}{y_t} = \lambda \left[\beta H (1-\tau) A_t^{\rho(1-\gamma)} e^{\frac{(1-\gamma)^2 \sigma^2}{2}} \right]^{\frac{1}{\gamma}}. \tag{3.1}$$

The next preposition summarizes the impact of a variation of A_t on the ratio $\frac{e_t}{y_t}$.

Proposition 3.1. *(a) Assume that $\rho > 0$. Then, $\frac{\partial\left(\frac{e_t}{y_t}\right)}{\partial A_t} \gtreqless 0$ if $\gamma \lesseqgtr 1$.*

(b) Assume that $\rho = 0$. Then, $\frac{\partial\left(\frac{e_t}{y_t}\right)}{\partial A_t} = 0$.

Proof: (a) It follows directly from (3.1) since $e^{\frac{(1-\gamma)^2\sigma^2}{2}} > 0$, $\lambda > 0$ and $H > 0$.

(b) When $\rho = 0$, $\tilde{A}_{t+1}$ does not depend on $\tilde{A}_t$ and hence, $\alpha = e^{\frac{(1-\gamma)^2\sigma^2}{2}}$. Therefore, $\frac{e_t}{y_t}$ is not affected by technology shocks.■

The intuition of this result comes directly from the assumption made about the utility function. The parameter γ measures both the inverse of IES and the relative risk aversion of individuals. Assume, for instance, that $\gamma > 1$. A high value of γ means that consumers want to keep a smooth path of consumption. Note that because of the assumption $\rho > 0$ an increase in $\tilde{A}_t$ implies an increase in expected $\tilde{A}_{t+1}$, which results in a rise in both present and future consumption. In this case, consumers decide to decrease $\frac{e_t}{y_t}$ in order to minimize the risk borne due to evasion. If consumers evade less income, the amount of evaded taxes is lower and this implies that the penalty is not as high as if they are caught. However, this intuition is not valid when the technology shocks are not correlated. In this case, when a technology shock takes place, both the true net income n_t and the output y_t increase. Because of the assumption of isoelastic preferences, taxpayers evade more. Therefore, as the aggregate evasion and the output rise in the same proportion, the ratio $\frac{e_t}{y_t}$ remains constant.

Finally, when $\gamma = 1$ (that is, the case with the logarithmic utility function), the consumption policy (2.20) is equal to

$$c_t = (1-\beta) n_t.$$

Note that what I have just obtained is exactly the same as the policy obtained when the tax evasion phenomenon is disregarded. The latter case is easily derived by making

$p\pi = 1$ so that $e_t = 0$ (see (2.21) and (2.15)). In fact, the parameters p and π characterizing the tax enforcement policy do not have any effect on the amount of consumption in period t for given values of both the tax rate τ and the capital stock k_t (see (2.20)). Therefore, the impact of a variation in the tax enforcement policy is totally absorbed by the amount of unreported income.

The total government revenue G_t is given by the taxes that consumers voluntary pay plus the amount of evaded taxes and the corresponding penalty paid by inspected individuals:

$$G_t = \tau x_t + p\pi\tau(y_t - x_t).$$

The government revenue G_t can be rewritten as

$$G_t = \tau y_t - \tau(1 - p\pi)e_t.$$

Therefore, the ratio $\frac{G_t}{y_t}$ equals to

$$\frac{G_t}{y_t} = \tau\left[1 - (1 - p\pi)\frac{e_t}{y_t}\right]. \tag{3.2}$$

The effect of a technology shock on the government revenue to output ratio is given in the following proposition:

Proposition 3.2. *(a) Assume that* $\rho > 0$*. Then,* $\frac{\partial\left(\frac{G_t}{y_t}\right)}{\partial A_t} \gtreqless 0$ *if* $\gamma \gtreqless 1$.

(b) Assume that $\rho = 0$*. Then,* $\frac{\partial\left(\frac{G_t}{y_t}\right)}{\partial A_t} = 0$.

Proof: It is immediate from Proposition 3.1 and equation (3.2).■

I have just shown that a technology shock not only affects the output per capita but also the government revenue to output ratio. The intuition of this result lies in the behavior of the ratio $\frac{e_t}{y_t}$ when A_t changes. As Proposition 3.1 shows, the effect of a positive technology shock on the ratio $\frac{e_t}{y_t}$ depends on the value that the parameter γ takes. When $\gamma > 1$, the ratio $\frac{e_t}{y_t}$ decreases and therefore, the government revenue to output ratio increases.

In this framework, the capital k_t is given at the beginning of each period t. Then, the output at time t is only affected by changes in the technology shock A_t. Therefore, knowing the sign of the effect of a technology shock on the government revenue to output ratio is the equivalent knowing whether the elasticity of tax revenue with respect to output is larger, equal or lower than one. Empirical evidence shows that the estimates of this elasticity are generally larger than one. This model can reproduce this fact when $\gamma > 1$ and technology shocks are correlated ($\rho > 0$). Note that in the case where consumers are honest (that is, when $p\pi = 1$) a technology shock will only affect the output per capital but not the ratio $\frac{G_t}{y_t}$, since from (3.2) I find that this ratio is equal to τ.

In order to extend the scope of my results, I will discus some potential scenarios concerning the behavior of government spending that give raise in turn to some insights about the procyclical or countercyclical nature of government deficits. Let us first consider the case where public spending is exogenously determined by the government. There is a large number of empirical works that use data from developing countries to suggest that government spending tends to be procyclical.[5] The articles by Gavin and Perotti (1997), Stein et al. (1999), Braun (2001), Kamisky et al. (2004), and Akitoby et al. (2004) constitute good examples of papers that find a positive relationship between public spending and output so that the elasticity of public spending with respect to output is positive. Now let us assume that the government wants to keep the government spending to output ratio constant, which is equivalent to fixing a unitary elasticity of public spending with respect to output. In this case, the behavior of the tax revenue to output ratio fully characterizes the path of fiscal deficits or fiscal surpluses. For instance assume that the government budget is initially balanced. If $\gamma > 1$ a positive technology shock has a larger effect on the tax revenue to output ratio than on the public spending to output ratio. Therefore, a budget surplus appears. However, when $\gamma < 1$ a positive technology shock results in a budget deficit. Note that when $\gamma = 1$ or $\rho = 0$, the government budget remains balanced. Nevertheless, when the elasticity of government spending with respect to output is larger than one, fiscal deficits can arise whatever value γ takes.[6] For $\gamma < 1$ and $\gamma = 1$ a positive technology shock gives rise to a fiscal deficit while in the case of $\gamma > 1$, deficits or surpluses appear depending on the specific value of both the elasticity of public spending and the

[5] A procyclical fiscal policy is defined as the reduction in public spending (or an increase in taxes) during recessions and increases in public spending (or reductions in taxes) during expansions.

[6] Akitoby et al. (2004) estimated the long and short term elasticity of government spending and output and found that this elasticity is on average greater than 1.

elasticity of tax revenue.

Consider now the case where the government is committed to devoting all tax revenue to financing public spending. Therefore, government spending becomes an endogenous variable and in consequence displays procyclical behavior. This setup can be interpreted as the extreme case of the model developed by Talvi and Végh (2005) where the government comes under political pressure to increase public spending when tax revenue increases because of positive shocks on output. In the setup of my paper the value of parameter γ will determine the magnitude of the elasticity of public spending with respect to output. In particular, when $\gamma > 1$ the elasticity of government revenue with respect to the output is larger than 1, which agrees with some empirical evidence that estimates the elasticity of public spending with respect to output (see Akitoby et al., 2004).

Traditionally, governments conduct their fiscal policies by modifying either the nominal tax rate or public spending. The introduction of the tax evasion phenomenon offers new instruments to government: the probability of inspection and the penalty rate. From expression (3.2), it is easy to see that the implementation of a tax enforcement policy that makes $p\pi$ closer to 1 results in an increase in the tax revenue to output ratio. Assuming that the government runs a balanced budget. Thus, an increase in tax revenue is automatically translated to public spending. So, the government can modify the initial effect of a technology shock on public spending to output ratio by means of the tax compliance policy.

4. Final Remarks

In this paper, I have shown that by introducing tax evasion to the standard Ak model growth with flat tax rates, it is possible to obtain an elasticity of tax revenue with respect to output larger than one which agrees with the empirical evidence.

I have considered a very simple model of capital accumulation where the static portfolio choice model of tax evasion presented by Allingham and Sandmo (1972) has been extended to a dynamic setup.[7] In this framework, consumers' decisions about how much income they want to report not only affect their present consumption but also their future consumption. Therefore, the response of consumers to positive technology

[7] See Lin andYang (2001) for a similar context.

shocks affects both the tax evasion decision and government revenue. In this setup I have shown how the effect of a positive technology shock on the government revenue to output ratio is fully characterized by the value of IES parameter when technology shocks are correlated. In particular when the IES exhibits a sufficiently small value, a positive technology shock forces individuals to more than proportionally lower their amount of evaded income in order to maintain a smooth path of consumption over time. Therefore, the government revenue increases more than the output and in consequence the income elasticity of tax revenue becomes larger than one.

References

[1] Allingham, M. G. and A. Sandmo, (1972). "Income Tax Evasion: A Theoretical Analysis." *Journal of Public Economics* 1, 323-38.

[2] Akitoby B., B. Clements, S. Gupta, and G. Inchauste (2004). "The Cyclical and Long-Term Behavior of Government Expenditures in Developing Countries." *IMF working paper* WP/04/202.

[3] Bruce D., W. Fox and M.H. Tuttle (2006). "Tax Base Elasticities: A Multi-State Analysis of Long-Run and Short-Run Dynamics." *Southern Economic Journal* 73, 315–341.

[4] Braun, M., (2001). "Why Is Fiscal Policy Procyclical in Developing Countries." (Harvard University).

[5] Dye R. (2004). "State Revenue Cyclicality." *National Tax Journal*, 57, 133-145.

[6] Dye R. and D. Merriman (2004). "State Revenue Stability: alternative conceptualizations. *Proceedings of the National Tax Association.* The 96th Annual Conference of the National Tax Association

[7] Gavin, Michael, and Roberto Perotti, 1997, "Fiscal Policy in Latin America," *NBER Macroeconomic Annual*, pp.11–71 (Cambridge, Massachusetts: MIT Press).

[8] Hakansson, N.H. (1970). "Optimal Investment and Consumption Strategies under Risk for a Class of Utility Functions." *Econometrica* 38, 587-607.

[9] Holcombe, Randall G., and Russell S. Sobel (1997) Growth and Variability in State Tax Revenue: An Anatomy of State Fiscal Crises. Westport, CT: Greenwood Press.

[10] Kaminsky, Graciela L., Carmen M. Reinhart, and Carlos Végh, (2004). "When it Rains, it Pours: Procyclical Capital Flows and Macroeconomic Policies." *NBER Working Paper*

[11] Kyland and Prescott (1982). "Time to Build and Aggregate Fluctuations." *Econometrica* 50, 1345-1370.

[12] Lin W.Z. and C.C. Yang (2001). "A dynamic portfolio choice model of tax evasion: Comparative statics of tax rates and its implication for economic growth." *Journal of Economic Dynamics & Control* 25, 1827-1840.

[13] Rebelo, S. (1991). "Long -Run Policy Analysis and Long-Run Growth." *Journal of Political Economy* 99, 500-521.

[14] Stein E., E.Talvi, and A. Grisanti, (1999). "Institutional Arrangements and Fiscal Performance: The Latin American Experience." Chapter 5 in James R. Poterba and Jürgen von Hagen.

[15] Talvi E. and C. Végh (2005). "Tax base variability and procyclical fiscal policy in developing countries." *Journal of Development Economics* 78, 156-190.

[16] Yitzhaki, S. (1974). "A Note on Income Tax Evasion: A Theoretical Analysis." *Journal of Public Economics* 3, 201-202.